I. Introduction

Background

Mountain areas throughout the developing countries share broadly common characteristics in terms of rapid population growth, accelerated degradation of the environment and natural resource base, unsustainability of the current resource use patterns, and deterioration in economic conditions. The Hindu Kush-Himalayan (HKH) Mountains, the Qinghai Plateau, the Tibetan Plateau, and the Loess Plateau constitute a large contiguous region in Asia where poverty persists and where the resource base continues to erode at an alarming rate. According to the classification of the United Nations, among the eight HKH countries, five, namely Afghanistan, Nepal, Bhutan, Bangladesh, and Myanmar are designated as least developed countries, whereas the remaining three, China, India, and Pakistan, are low income countries, although their mountain areas are, however, in the "least developed" category. Concomitant with this spectrum of poverty and a degraded resource base is the plight of mountain people, especially remote mountain people. Their productivity is amongst the lowest and their quality of life amongst the poorest in the world.

More and more mountain areas of the HKH show distinct signs of unsustainability, decreasing soil fertility, and a high degree of instability. There is a trend of abandoning agricultural land, and this sharply contrasts with the decrease of land/man ratio in cultivated areas. This applies in particular to areas with steep topography and fragile slopes located in monsoon-affected regions with high rainfall intensity. Steep and fragile slopes are being increasingly cultivated and no longer kept under the protection of forest cover; this leads to landslides and large-scale loss of soil. The reduced flexibility and diversity of agriculture (i.e., complex of land-based activities) and resource regenerative processes, that helped to sustain natural resource use systems in a low demand situation, are other visible manifestations of the emerging scenario in most parts of the HKH Region (Jodha et al. 1992).

The rapid population growth increased the density of population on limited productive land. The necessity of meeting increasing food, fuelwood, and fodder requirements, on the one hand, and demands generated by market forces and public interventions, on the other, are the most important factors which affect agriculture in the mountains and accelerate the process of resource extraction both in forests and on farmlands. The decades of emphasis on food production without appropriate land improvement techniques have now resulted in soil erosion which has become a major environmental problem (Jodha et al. 1992).

Reconciling Extensive and Intensive Land Uses

In the past, soil erosion control through terracing, clearing of boulders, and planting trees has been the response of farmers and development agencies to the problems outlined above, but, in many cases, this response is no longer possible or workable, neither economically nor environmentally.

Currently, many areas under cultivation cannot be terraced because either the slopes are too steep or the available topsoil layer is inadequate. Terraces have been established in most areas where this is feasible. However, the terraces made on many steep slopes that are located in unsuitable areas often collapse because of heavy rainfall or because the construction of the terraces is not firm enough. The nutrient contents and soil fertility under such conditions are very low and will decline further, which in turn results in low productivity per unit area. In addition, in some remote areas terracing is very expensive, both financially and in terms of labour, and farmers cannot afford it.

One obvious solution, under such conditions, would be to de-intensify appropriate species and put the steep slopes back under forests. However, this solution is not acceptable, either on economic or on social grounds, since a large (and increasing) number of people in the hills and mountains have to depend directly upon these lands for their livelihood. Thus the key question of reconciling long-term environmental and resource conservation issues with the short-term survival strategies of mountain people is a major

challenge for the policy- makers and development agencies engaged in mountain areas.

The past efforts in practically all countries of the HKH Region have emphasised reforestation as a key component of resource conservation protection strategies. However, the efforts have met with only mixed success. The reasons for the failures are not difficult to find. While these initiatives fully recognised natural convergence between attributes of trees or forests, i.e., their resource-conserving effects, and imperatives of fragility characterising steep slopes, i.e., need for low intensity land use patterns, they did not examine the resource-intensive, high productivity, quick pay-off dimensions which could have made the resource-extensive system readily acceptable to the people to meet their short-term needs.

This calls for focussing on multiple, goal-centred strategies for resource conservation and rehabilitation. An important component of such strategies would be a choice of species that can simultaneously satisfy the long-term conservation needs as well as the short-term economic needs of the people depending upon rapidly degrading mountain resources.

Seabuckthorn is one such species that has great potential for satisfying the above requirements. The total distribution of seabuckthorn in three of the main producing countries, namely, China, Mongolia, and the former USSR is approximately 810,000 ha (natural growth) and 300,000 ha (plantation). Out of the total, approximately 740,000 ha and 300,000 ha of natural and cultivated plants respectively are in China (Koykov 1985, Huang Quan et al. 1990, Lu Rongsen 1991). However, outside China, seabuckthorn is hardly used or cultivated in the HKH Region. This paper, using experiences and evidence from China, discusses both the technical and economic aspects of seabuckthorn and indicates its prospects in different countries of the HKH Region.

Why Seabuckthorn ?

Usually, in order to control the loss of water and soil, engineering and biological measures are adopted hand in hand. Amongst the biological measures, a number of trees, shrubs, and grasses are commonly used. Since the 1950s, Chinese scientists, technicians, and farmers have been trying out many plant species. Some of them are very successful and have been used in different ecological areas. For example, Chinese Pine (*Pinus tabulaeformis*), Poplar (*Populus spp*), and Elm (*Ulmus spp*) are tree species which grow fast, can resist relatively arid weather, and can be used for timber. False Indigo *(Amorpha fruticosa)*, Pea Shrub (*Canagana korshinskii)*, Sweet Vetch (*Hedysarum scoparium*), Mongolian Sweet Vetch (*Hedysarum mongolicum*), and Sand Willow (*Salicheilophila*) are excellent shrubs that grow fast, can resist drought, cold, and wind, and can quickly occupy the ground surface so as to protect the soil from erosion. In addition, they can provide large amounts of leaves for animal fodder. Some of them even have the ability to fix nitrogen. Erect Milk Vetch (*Astragalus adsurgens*) is a perennial grass which can also resist cold, drought, wind, and sandstorms and can also grow on lean alkaline and saline soils.

Beyond a doubt, these species have played a very important role in the biological measures of water and soil conservation. In the 1970s, some species were even planted on a large scale by air-seeding on the Loess Plateau. But these successful experiences could not be adopted in other places without government persuasion and subsidies; most farmers were not willing to adopt the experiences because they did not get direct economic benefits from planting these plants. The farmers said "*If the Government gives the money, we will plant the trees*". That is the main reason why these successful experiences did not gain widespread popularity.

When information relating to seabuckthorn use in the Soviet Union reached China at the beginning of the 1980s, scientists, enterprises, and government officers were surprised to hear of its rich nutrients and useful medical properties. They became aware of its tremendous economic as well as ecological benefits. Then a great upsurge of studying, exploiting, and planting of seabuckthorn commenced throughout the northern, the north-western, and the south-western parts of China.

Why did seabuckthorn draw attention over other plants used in soil and water conservation? And why on a very prominent scale? This is explained by the unique characteristics of seabuckthorn that are summarised below.

1. It is a deciduous shrub and is widely distributed throughout the temperate zones of Asia and Europe and throughout the subtropical zones of Asia at high altitudes. Growing at altitudes ranging between a few metres to 5,200 metres, seabuckthorn (*Hippophae*) can resist low temperatures of up to - 43° C and can withstand heat of 40° C. Some species grow well in

regions that only have a precipitation of about 300mm while others can endure inundation. Some species grow in soils with a pH of 9.5 while others grow even in soils that contain 1.1 per cent salts.

2. Seabuckthorn has a highly developed root system and therefore presents an excellent biotic choice for holding the soil on a fragile slope. In many locations, a five-year old plant will have a tap root of up to three metres deep and horizontal roots extending between six to ten metres. Two or three years after its plantation, root turion seedlings sprout from the horizontal roots creating many new generation plants. With only four plants spaced out two to four metres apart, the entire area surrounding these plants will be completely covered within three to five years. In the planted areas, the loss of topsoil caused by seasonal monsoons will decrease to less than 30 per cent and more than 80 per cent of water will be held in the ground.

3. Seabuckthorn also has an outstanding ability to take root even in poor soils, because of its ability to fix nitrogen directly from the air through the nodules in its roots. It is estimated that about 180kg of nitrogen/hectare/annum can be fixed in the soil around seabuckthorn forests. The seabuckthorn roots also act to transform insoluble organic and mineral matters in the soil into more absorbent states. In terms of ability to improve the physical and chemical properties of soil, seabuckthorn, as a pioneer plant within a fragile and marginal context, has had remarkable success.

4. There is also an extraordinary economic aspect to seabuckthorn. A natural seabuckthorn forest can yield 750 to 1,500kg of berries per hectare. Its small, orange-coloured fruit is a storehouse of vitamins and important bioactive substances. The Vitamin C content is 5 to 100 times higher than any other fruit or vegetable known. Its pulp and seeds contain high quality oil which is regarded to be very important for its medical value. Thus, the seabuckthorn fruit is being used as a raw material for producing food, medicines, and cosmetics. In addition, the seabuckthorn plant is a good source of firewood. In a six-year old seabuckthorn forest, each hectare can produce 18 tons of firewood, equal to nearly 12.6 tons of standard coal.

5. Many years ago, people knew that seabuckthorn could serve as a water and soil conservation plant but few people knew about its huge economic benefits. In the valleys and mountains, seabuckthorn plants grow, flourish, and die naturally. Because of its ability to fertilise soil, farmers used to dig out seabuckthorn and then plant potatoes or other crops on fields from which seabuckthorn had been removed. Sometimes, for reforestation, they destroyed seabuckthorn bushes instead of planting them. That is why massive seabuckthorn forests could only be seen in very remote areas.

   After the economic benefits of seabuckthorn were revealed, farmers came to consider seabuckthorn a valuable resource. Increasing cultivation of seabuckthorn attests its multipurpose usage and tremendous value-added properties. For the farmers living in the mountains, seabuckthorn offers them the opportunity to maintain a more sustainable livelihood, while protecting their land from soil erosion. The use of seabuckthorn illustrates how low input costs and careful planning can lead to quite substantial benefits; a good example of mountain perspective-oriented, sustainable development. Seabuckthorn thus qualifies as a unique option for the simultaneous management of several problems emanating from the fragility, marginality, inaccessibility, and diversity characterising mountain areas.

In the following discussion, first (Chapter 2) we introduce seabuckthorn by describing its botanical features and its geographical spread. The next chapter (3) deals with the harnessing of seabuckthorn for economic gains. A variety of economic usages in China and the former USSR are described with quantitative evidence. In Chapter 4, environmental functions of seabuckthorn (i.e., for resource conservation/rehabilitation) are described by extensively narrating the experiences from the Loess Plateau in China. Some operational details on plantation and management of seabuckthorn are discussed in Chapter 5. The last chapter briefly indicates the scope and prospects of popularising seabuckthorn as a multipurpose option in different parts of the HKH Region. It also describes experiences with seabuckthorn cultivation and commercial exploitation in three countries, namely China, Mongolia, and Russia.